DESIGN MECHANICAL, ELECTRICAL AND PLUMBING OR MEP OF PESMA BUILDING

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UNIVERSITY MUHAMMADIYAH SURAKARTA

2017

APPROVAL

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UNIVERSITY MUHAMMADIYAH SURAKARTA

SCIENTIFICE PUBLICATION

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DESIGN MECHANICAL, ELECTRICAL AND PLUMBING OR MEP OF PESMA BUILDING

Abstract

The Pesma Building is a very important place, besides being used as a dormitory, the Pesma building is also used as a place living and for classes Education or study. This research is to develop or upgrade the Pesma buildings such as, those without air conditioning, to install air conditioning system management. And the system is not effective; to develop a more standardized system. In the construction of Pesma building there are several supporting elements that must be prepared, one of which is about mechanical and electrical that can't be separated from the use of buildings such as electrical installation design using AutoCAD software, and using DIAlux programing to determining the number of light points, and using Microsoft Excel to determining or measure about air conditioner system, like capacity, BTU, current and others ,and about plumbing system, like , water needed, amount of duty water , and others. fire extinguishers, lightning rods, and the required power capacity. The planning result shows that the Pesma Building has a total current of 699.87 A. And uses the main safety of MCCB 750 A with NYY 4 x 1 x 300. The building also needs clean water capacity of 87.2 m3 / day and the ground tank dimension of 20 x 20 x 3 meter that can hold water for 2 days amounted to 1300 m3.

Keyword: *MEP, Pesma building, Design of MEP system, CAD pesma*

Abstrak

Gedung Pesma merupakan tempat yang sangat penting, selain digunakan sebagai asrama, bangunan Pesma juga digunakan sebagai tempat tinggal dan untuk kelas Pendidikan atau studi. Penelitian ini bertujuan untuk mengembangkan atau meng-upgrade bangunan Pesma seperti, tanpa AC, untuk memasang manajemen sistem pengkondisian udara. Dan sistemnya tidak efektif; untuk mengembangkan sistem yang lebih terstandarisasi. Dalam pembangunan gedung Pesma ada beberapa elemen pendukung yang harus disiapkan, salah satunya adalah tentang mekanik dan listrik yang tidak dapat dipisahkan dari penggunaan bangunan seperti desain instalasi listrik dengan menggunakan software AutoCAD, dan menggunakan program DIAlux untuk menentukan jumlah titik terang, dan menggunakan Microsoft Excel untuk menentukan atau mengukur sistem pendingin ruangan, seperti kapasitas, BTUjumlah air tugas, dan lain-lain. alat pemadam kebakaran, batang petir, dan kapasitas daya yang dibutuhkan. Hasil perencanaan menunjukkan bahwa Gedung Pesma memiliki arus total 699,87 A dan menggunakan keamanan utama MCCB 750 A dengan NYY 4 x 1 x 300. Bangunan ini juga membutuhkan kapasitas air bersih 87,2 m3 / hari dan dimensi tangki tanah 20 x 20 x 3 meter yang bisa menampung air selama 2 hari berjumlah 1.300 m3.

Kata kunci: *MEP, Pesma building, Design of MEP system, CAD pesma*

1. INTRODUCTION

The Pesma Building has an important role in a university because as a dormitory for students of Muhammadiyah of Surakarata university. With the construction of the building the Pesma is expected to make a place to live and study to be happy.

In the construction of the building there are several plans, a part from the planning of building structures, building architecture, a building also requires electrical mechanical planning and plumbing such as lighting installation, air conditioner, plumbing system, fire system, and lightning rod. For the sake of the smooth activity of the building, then made electrical mechanical planning and plumbing with proper calculation, and safe at the time of manufacture and use. Coordination involves defining locations for branch components of systems in congested spaces to avoid interferences and comply with diverse design and operations criteria

1.1 Problem Formulation

Based on the background that has been described above, it can be formulated some problems as follows:

1. Knowing the amount of electric power capacity required in the Pesma building.
2. Calculate the need for clean water, hydrant and dirty water systems in the Pesma building.

1.2 Limitation Problems

In order to fit the objectives and targets expected in the writing of the Final Project, then made some limitations of the problem as follows:

1. Determine what loads are required on the Pesma building
2. Determining the total current from the load and the safety capacity used.
3. Make design of electrical installation planning using AutoCAD.

1.3 Research purposes

1. Design the electrical system and electrical power capacity required in the Pesma building

2. Designing clean water system, hydrant and dirty water in the Pesma building

In the Pesma building has a length of 59.8 meters, width of 15 meters and height of approximately 14.4 meters, and has 5 floors. Area for 1 floor of 897 m2 and total area of 4,485m2.

1.4 Research Benefits

Benefits of writing this final task are:

1. Add knowledge about Plumerical mechanical electrical planning in a multi-story building especially for students of electrical engineering.
2. Adding skills in terms of mechanical design of electrical plumbing using AutoCAD software.

Some of the formulas and theories concerning electrical mechanical planning in the recto rate building are:

1. Determine the number of light points in a room

$$N = \frac{L \times W \times H \times E}{\text{lumen of lamp} \times LLF \times CU \times n} \quad (1)$$

Where:

N = Number of light points in the room
L = length of room (m)
W = width of the room (m)
H = Height (height of room - 0.80) (m)
E = Powerful illumination (lux)
$Lumen$ = Lumen lights
n = Number of lights in a single point
LLF = Light Loss Factor / light loss factor (0.7-0.8)
CU = Coefficient of utilization (50-65%)

2. Determining the capacity of AC (Air Conditioner) in the room

$$\text{Needs BTU} = (L \times W \times H \times I \times E) + (number\ of\ people \times calories\ people) \quad (2)$$

Where:

L = Length of Room (feet)
W = Room Width (feet)
H = Height (feet)
I = Value10 if insulated (room is lower ground or coincide another room)
Value18 if the room is not insulated.
E = Value 16 if the longest wall of the room faces north;
= Value of 17 if the longest wall of the room facing east;
= Value 18 if the longest wall of the room faces south;
= Value 20 if the longest wall of the room faces west.

(1meter=3.28feet)

3. Plumbing calculations

The function of plumbing Equipment is first, to provide clean water to the desired places with sufficient pressure, and secondly, discharging dirty water from certain places without defraying an important part.

a. Determine the total number of occupants in a building:

total number of occupants = number of floors x number of people per floor (3)

b. Clean water requirement:

Total clean water requirement = water requirement of average person per day x total number of occupants (4)

c. Water needs for fire extinguishers (hydrant):

need supply hydrant = standpipe capacity used(GPM) x shutdown time (5)

d. Ground tank capacity:

Water on ground tank is used for 2 days ground tank capacity = (2 days x total amount of clean water requirement) + water firefighting (6)

e. Capacity of roof tank:

Calculated based on the number of unit load (FU) on the building. After that the result of the total FU is seen on the graph of the unit load relationship with the flow discharge in the attachment. So how many liters / minute discharge of water flow in the building. Flow discharge is used to determine the capacity of roof tank with formula:

roof tank capacity = amount of water flow discharge x plan time of charging roof tank (7)

4. Determination of the current

To determine the capacity of MCB to be used.

For single phase load:

$$Ia = \frac{P}{V_{L-N} Cos\varphi} \quad (8)$$

For a three phase load:

$$Ia = \frac{P}{\sqrt{3}.V_{L-L}.Cos\varphi} \quad (9)$$

By:

Ia = nominal current (A).
VL-N = Neutral-phase voltage (V).
VL-L = Phase-phase voltage (V).
P = Power load (watts)
Cos φ = Power factor

2 METHODS

In the mechanical design of electrical and plumbing in Pesma Building there are several stages, namely:

1. Analysis of building plan drawings.

This step to determine what loads will be installed on the building and its amount.

2. Determine the design of the building installation.

Having determined the overall calculation, then it can be designed that installation right for this building in accordance with the provisions of international standards

3. Determine the materials needed

Selection of the right materials can avoid harm to humans and supports the reliability of electrical installations. All equipment used on the installation must be reliable and both mechanically and in a manner its electricity.

2.1 Flowchart of planning

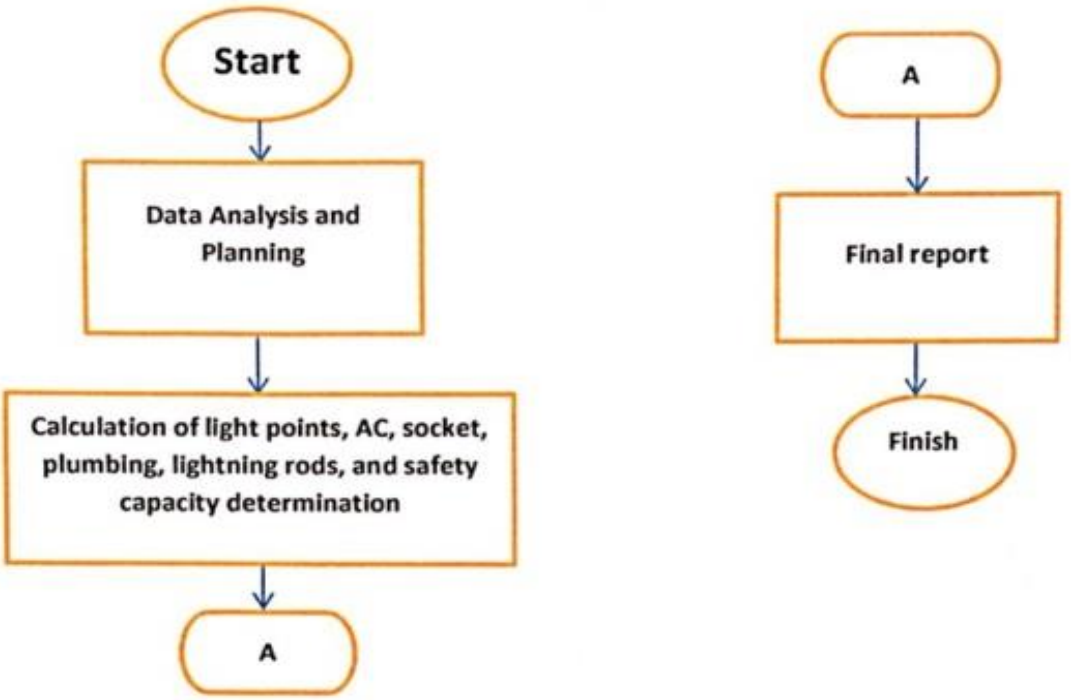

Figure1. Flow Chart of Planning

3. RESULTS AND DISCUSSION

The Pesma building has a length of 59.8 meters, a width of 15 meters and a height of approximately 15 meters, and has 5 floors. Area for 1 floor of 897 m2 and total area of 4485 m^2

3.1 DETERMINATION OF LIGHT POINT

Ex. Classroom C.B.1

This room has a length of 11.4 meters, width of 4.7 meters, and height of 3.2 meters. In this room wear a 40 watt Phillips fluorescent lamp with a lumen of 6000. The target for the illumination that will be achieved is 250 because this room includes office space. The light loss factor used is 0.8 and the coefficient of utilization is 50%. To determine the number of light points used in this room used equation 1:

$$N = \frac{L \, x \, W \, x \, H \, x \, E}{lumen \; lampu \; x \; LLF \; x \; CU \; x \; n}$$

$$= \frac{11.4 \text{ x } 4.7\text{x } 3{,}2 \text{ x } 450}{6000 \text{ x } 0{,}8 \text{ x } 0{,}5 \text{ x } 6}$$

$$= 5.358$$

So in class C. B.1 using the number of points of light as much as 6 with 1 lamp in one point. Wear type lamp Phillips TMS022 Neon lamp 40 watt

3.2 AC CAPACITY

For AC capacity used in the C. B.1 can be determined first BTU requirement per hour of room calculated using equation 2:

$$\text{Needs BTU} = (\text{L x W x H x I x E}) + (number\ of\ people\ x\ calories\ people)$$

$$= (11.4\text{x } 4.7 \text{ x } 3.2 \text{ x } 10\text{x } 37) + (35 \text{ x } 600)$$

$$= 59063.235 \text{ BTU/Hrs.}$$

From the BTU requirement obtained can be determined AC used for the class that is as much as three pieces with a capacity of 2 PK + 2 PK + 2 PK.

3.3 ELECTRIC SOCKET

Assumed there are several sockets in class C. B.1, including 1 projector socket, and socket for laptop as much as 2 pieces, and ampere obtained for 4.54 A per socket. total ampere is 13.6 A.

3.4 PLUMBING SYSTEM

1. The calculation of plumbing In the Pesma building can be determined using by following:

A. Determining amount of people from this building:

Total number of occupants = (number of floors x number of people per floor) + people first floor.

= (4 x 88) + 210

= 562 people

2. Needs clean water:

A. total clean water requirement = water requirement of average person per day x the total number of occupants

= (200 x 352) + (210 x 80) people

= 87,200 liters / day

= 87.2 m^3 / day

3.5 NEEDS OF FIRE WATER (HYDRANT)

1. Water needs hydrant = standpipe capacity used (GPM) x shutdown time

= 1500 GPM x 45 minutes

= 67500 gallons

2. Water requirement 5 floors = 67500x 5

=337,500 gallons

=1,275,750 liter

=1,275.75 m^3

3.6 CAPACITY GROUND TANK

Water on ground tank is used for 2 days

Ground tank capacity = (2 days x total amount of clean water requirement) + fire extinguishers

= (2 days x 87.2m3 / day) + 1275.75

= 174.4 + 1275.75

= 1450.15 m^3

Safety 10% = ground tank capacity (ground tank x 10% capacity)

=1450.15 + (1450.15 x 10 %)

$= 1450.15 + 145.015$

$= 1595.2$

$= 1600\ m^3$

3.7 CAPACITY OF ROOF TANK

Calculated based on the number of unit load (FU) on the building. From the calculation result based on the number of load units contained in the attachment, got the amount for 5 floors = 302 FU (table). After that see graph of load unit relationship with flow debit. From the number of load units obtained 450 liters / minute discharge of water flow within the building.

Planned roof tank can be filled within 30 minutes, then the water capacity for roof tank are:

Capacity roof tank = (450 x 30 minutes)

$= 13{,}500$ liters

$= 14\ m^3$

3.8 LIGHTNING ROD

The Pesma building has a length of 59.8 meters, width of 15 meters, and height of about 15 meters. This building uses lightning protection type E.F Lightning Protection type with 10 meter pole height which has 100 meter protection radius.

3.9 ELECTRICAL POWER SHARING

1. **1st floor SDP panel**

A. Load of AC, for first phase

Phase R = 42.4+50.8= 93.2 A

B. Load of Light + load of AC + load of socket

Phase S = 49+33.9+43.98= 126.88 A

C. Load of Light + load of socket

Phase T = 39.08 + 34.32 + 34.12 = 107.52 A

The sum result per phase for each load shows the largest total current is 126.88 A, it is used MCCB 3 phase protection of size 160 A with NYY 4 x 70

2. **2nd floor SDP panel**

A. Load of AC, for first phase

Phase R = 40.8+40.8+40.8= 122.4 A

B. Load of AC +(load of Light + load of socket)

Phase S = 40.8+47.31= 88.11A

C. (Load of Light + load of socket)+(load of Light + load of socket)+(load of Light + load of socket)

Phase T = 42.56+43.04 + 38.23 = 123.83 A

The sum result per phase for each load shows the largest total current is 123.83A, it is used MCCB 3 phase protection of size 160 A with NYY 4 x 70

3. **3nd floor SDP panel**

A. Load of AC, for first phase

Phase R = 40.8+40.8+40.8= 122.4 A

B. Load of AC +(load of Light + load of socket)

Phase S = 40.8+47.31= 88.11A

C. (Load of Light + load of socket)+(load of Light + load of socket)+(load of Light + load of socket)

Phase T = 42.56+43.04 + 38.23 = 123.83 A

The sum result per phase for each load shows the largest total current is 123.83A, it is used MCCB 3 phase protection of size 160 A with NYY 4 x 70

4. **4nd floor SDP panel**

A. Load of AC, for first phase

Phase R = 40.8+40.8+40.8= 122.4 A

B. Load of AC +(load of Light + load of socket)

Phase S = 40.8+47.31= 88.11A

C. (Load of Light + load of socket)+(load of Light + load of socket)+(load of Light + load of socket)

Phase T = 42.56+43.04 + 38.23 = 123.83 A

The sum result per phase for each load shows the largest total current is 123.83A, it is used MCCB 3 phase protection of size 160 A with NYY 4 x 70

5. 5nd floor SDP panel

A. Load of AC, for first phase

Phase R = 40.8+40.8+40.8= 122.4 A

B. Load of AC +(load of Light + load of socket)

Phase S = 40.8+47.31= 88.11A

C. (Load of Light + load of socket)+(load of Light + load of socket)+(load of Light + load of socket)

Phase T = 42.56+43.04 + 38.23 = 123.83 A

The sum result per phase for each load shows the largest total current is 123.83A, it is used MCCB 3 phase protection of size 160 A with NYY 4 x 70

6. Panel SDP Water Pump

Transfer pump 1 phase with 250 watt power

$$Ia = \frac{P}{V_{L-N} Cos\varphi}$$

$$= \frac{250}{220.0,85}$$

$$= 1.336 \text{ A}$$

Deep well pump in a 1 phase pump with 600 watts

$$Ia = \frac{P}{V_{L-N} Cos\varphi}$$

$$= \frac{600}{220.0,85}$$

$$= 3.20 \text{ A}$$

Booster pump 1 phase with 970 watts

$$Ia = \frac{P}{V_{L-N}.Cos\varphi}$$

$$= \frac{970}{220.0{,}85}$$

$$= 5.18 \text{ A}$$

Total load for water pump:

Phase R = 3.20 A

Phase S = 5.18 A

Phase T = 1.336 A

The sum of each phase of each water pump shows the largest total current is 5.18A, then used a 3-phase MCB protective measure of 20 A with NYY 4 x 2.5 introductory cable.

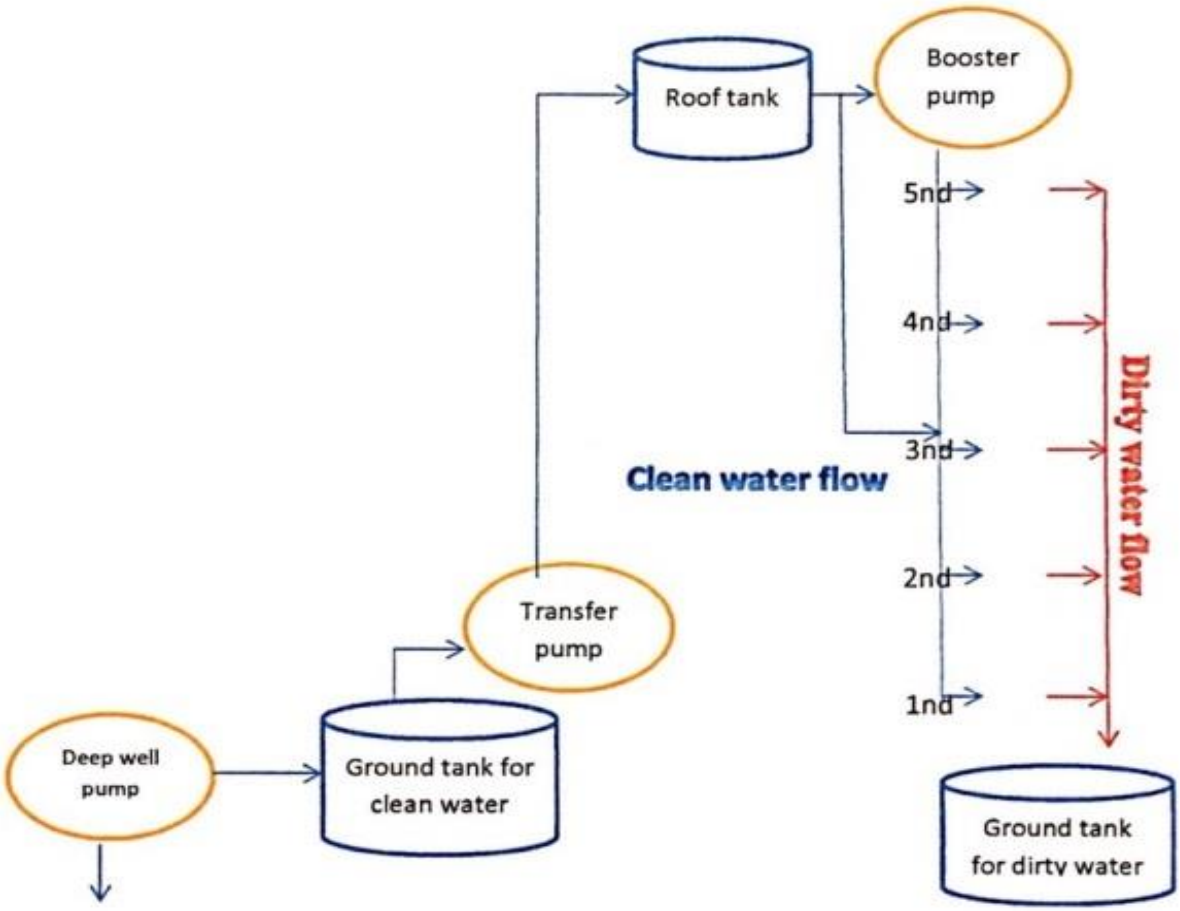

Figure2. Plumbing system Panel

7. **Panel SDP hydrant pump**

A. 3 phase Jockey pump with 11000 watt power.

$$Ia = \frac{P}{\sqrt{3}.V_{L-L}.Cos\varphi}$$

$$= \frac{11000}{\sqrt{3}.380.0,85}$$

$$= 1.96 \text{ A}$$

B. 3 phase electric pump with 45000 watt power.

$$Ia = \frac{P}{\sqrt{3}.V_{L-L}.Cos\ \varphi}$$

$$= \frac{45000}{\sqrt{3}.380.0,85}$$

$$= 80.5\ A$$

The result of the phase sum of each water pump shows the largest total current is 80.5A, then used the safety of MCB 3 phase of size 100 A with NYY 4 x 25.

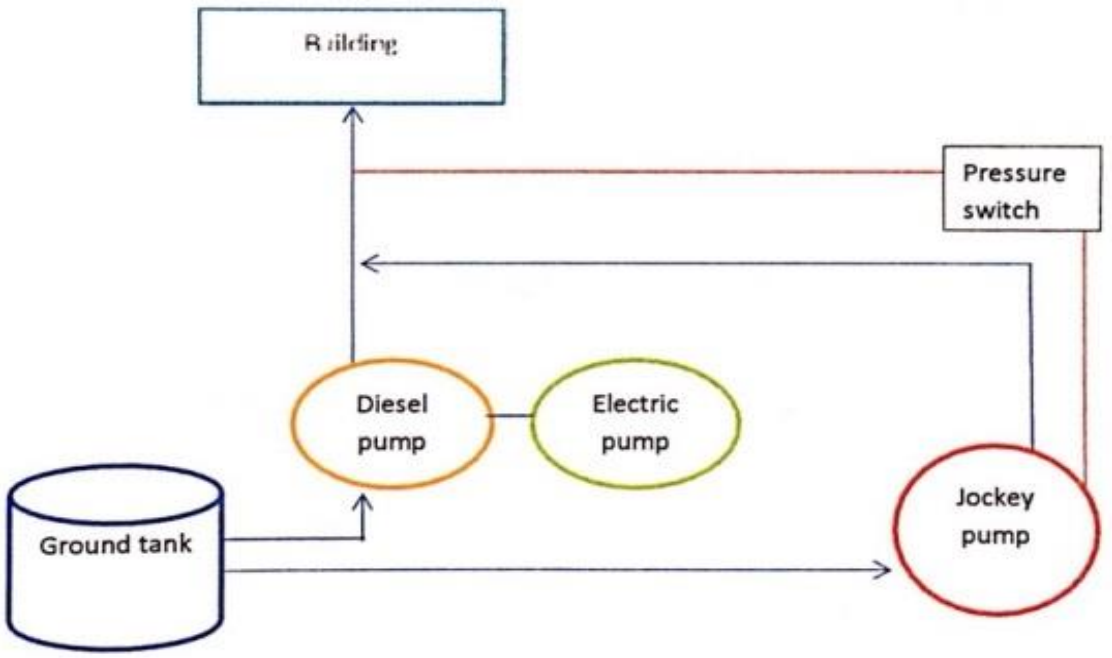

Figure3. Hydrant system Panel

8. **MDP Panel**

The calculation of MDP panels is determined by summing each number of phases R, S, T per load.

Phase R =582.8+ 3.20+95.7= 681.7 A

Phase S = 479.28+5.18+95.7=580.16 A

Phase T = 602.84+ 1.336+80.5= 684.68 A

The total phase sum of all loads shows the largest total current is 684.68A, then used MCCB 3 phase safety measure 750A with NYY 4 x 1 x 300 mm2 conductor cable. The electrical power used by this building is √3 x 380 x 750 A = 493.620 VA.

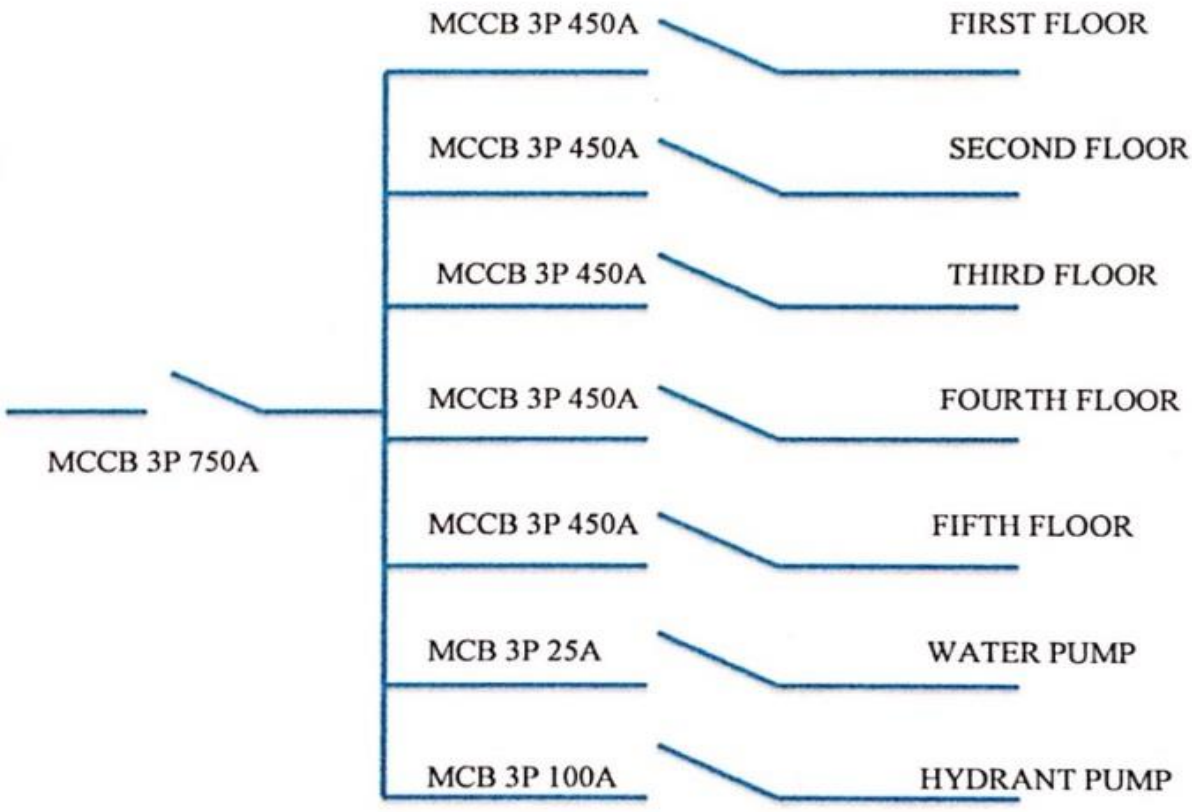

Figure4. Single Line Diagram of MDP Panel

4. CONCLUSION

Based on the above analysis and calculation can be concluded as follows:

a. The Pesma Building has a total current of 699.87 A using MCCB 3 phase margin of 750 A.
b. Needs of clean water required in this building amounted to 87.2 m3 / day with the assumption that the number of occupants as much as 562 people.
c. This building uses power supply from PLN of 493.6 kVA and uses power supply from generator (if electricity from PLN lost) 500 kVA.

5. REFERANCES

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